RELIABILITY MANAGEMENT

RELIABILITY MANAGEMENT

- **The direction and control of the reliability activities of the organization including staffing, providing facilities (computers, software etc.), establishing reliability goals and policies, and the facilitating of the interaction of reliability personnel with the remainder of the organization.**

(This is the instructors suggested definition--how can it be improved?)

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Why Beneficial?

- **Like quality control, the establishment of JIT, ISO 9000 certification and true statistical process control in the organization, reliability must have unequivocal top-down support.**

- **Without this, the reliability function, will only "be going through the motions."**

- **With effective support future bottom line costs and total cost of ownership can be drastically reduced. The resultant cost benefits to the company, though difficult to capture with traditional accounting methods, will increase productivity up to 40% or more.**

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OBJECTIVES

Be able to answer (or perform):

- **What types of reliability management structures are there?**

- **What are the objectives of reliability management?**

- **What are the key reliability disciplines?**

- **How does the reliability discipline interact with the rest of the organization?**

- **Describe what activities you would set up for a reliability program to support a project. What metrics would you use?**

- **How do reliability activities benefit the project?**

- **What is human engineering and how does the human element affect reliability?**
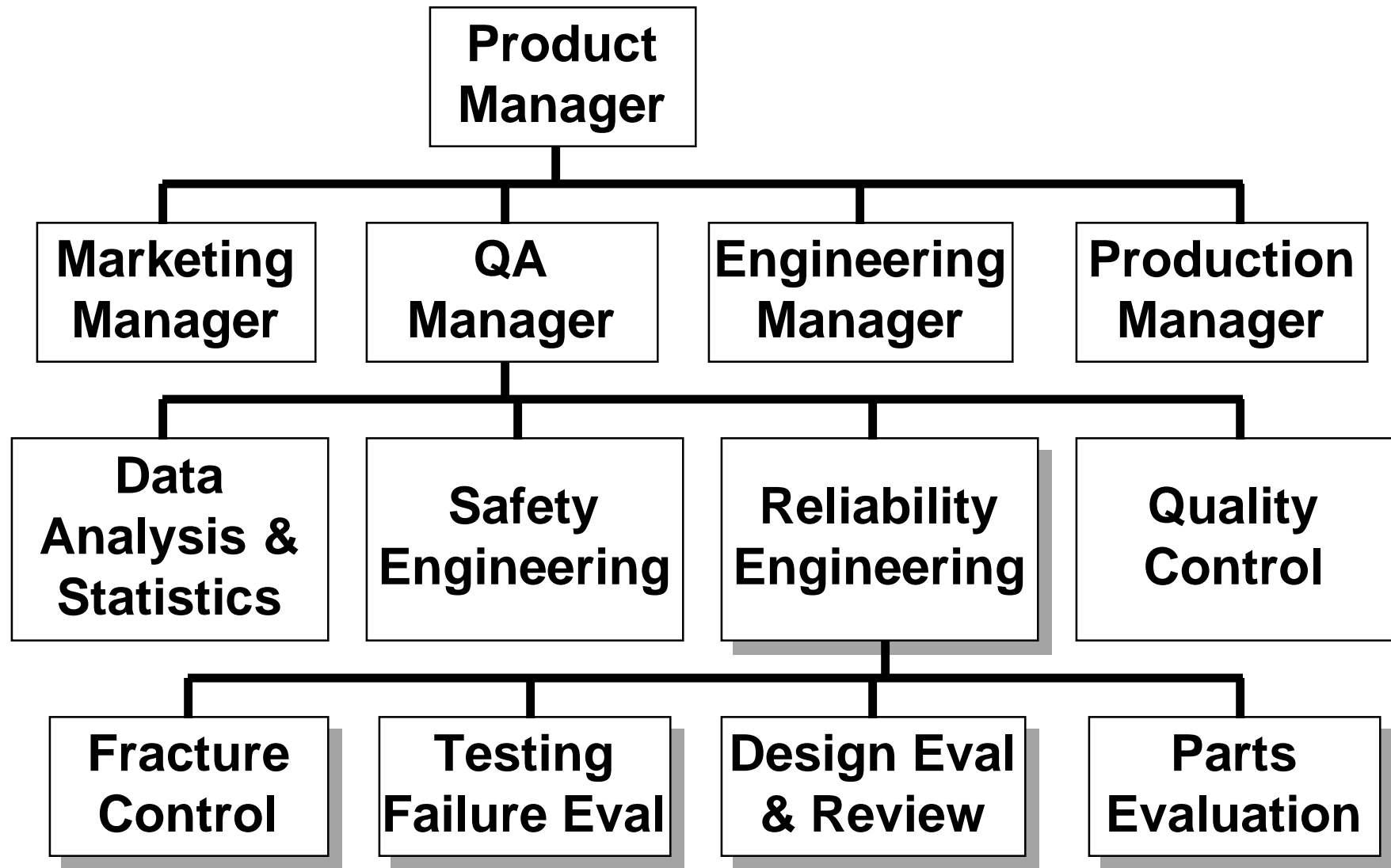
4

Outline: Reliability

- **Types of Reliability Organizations.**
- **Reliability and Systems Engineering.**
- **Establishing a Reliability Program.**
- **Examples of Reliability Objectives.**
- **Metrics for Reliability.**
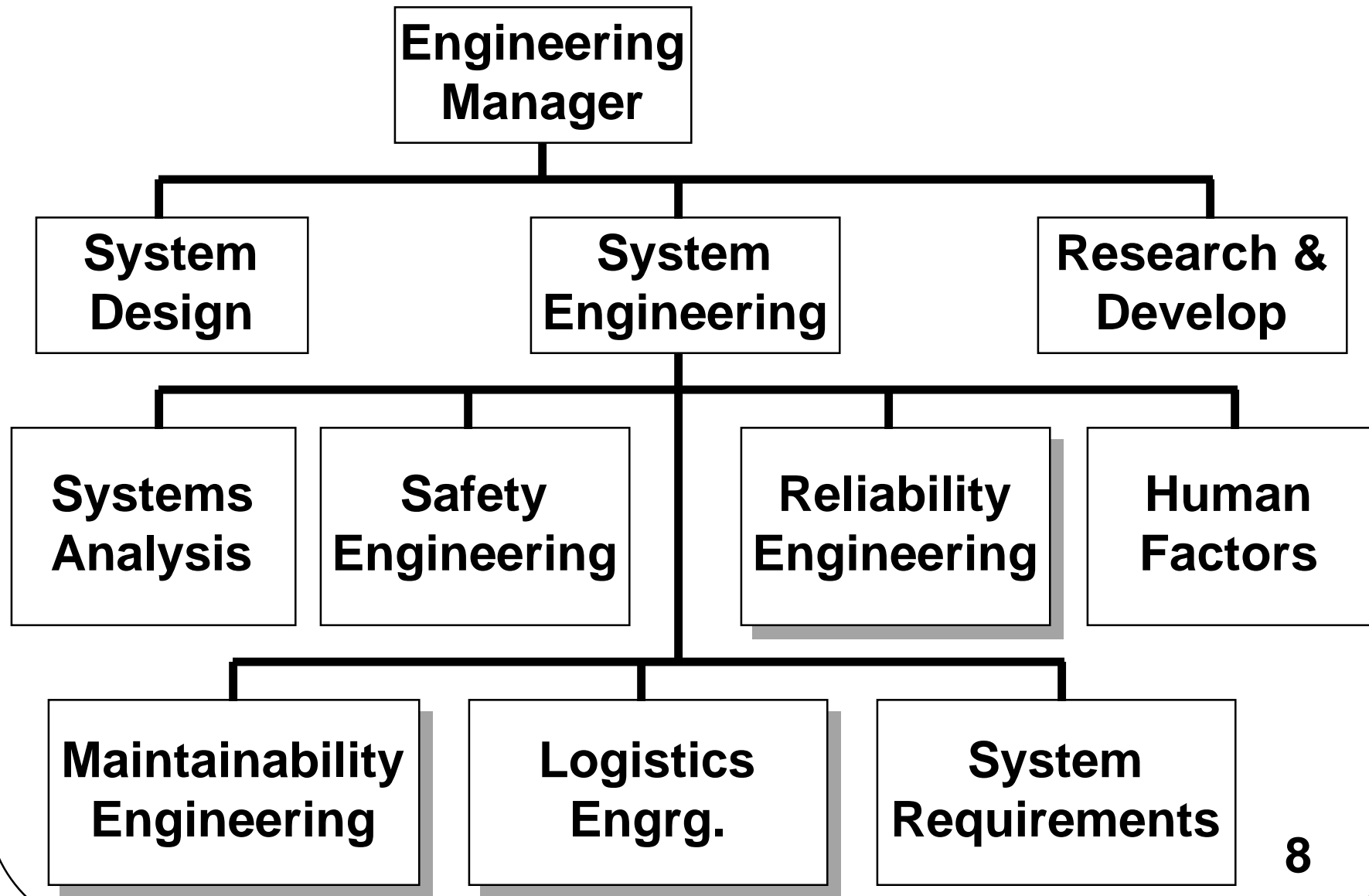- **Human Reliability**

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Reliability Organization: Staffing

- **Need staff familiar with the design, manufacture and testing methodology of the product and familiar with statistical techniques.**

- **Use senior staff from engineering organizations who are intimately familiar with product and the history of failures/problems encountered with the design, test and manufacture of the product.**

- **Use engineers with formal reliability engineering discipline as a complement to the above.**

- **All these engineers must be capable of having a close working relationship with design and test and be capable of interacting with them in a win-win atmosphere.**

- **Part of normal engineering training rotation.**

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Reliability Organization: QA Based

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                        ┌──────────────┐
                        │   Product    │
                        │   Manager    │
                        └──────┬───────┘
        ┌──────────────┬───────┴───────┬──────────────┐
┌───────────────┐ ┌─────────────┐ ┌───────────────┐ ┌──────────────┐
│   Marketing   │ │     QA      │ │  Engineering  │ │  Production  │
│    Manager    │ │   Manager   │ │    Manager    │ │   Manager    │
└───────────────┘ └──────┬──────┘ └───────────────┘ └──────────────┘
        ┌──────────────┬──┴──────────┬──────────────┐
┌───────────────┐ ┌─────────────┐ ┌───────────────┐ ┌──────────────┐
│     Data      │ │   Safety    │ │  Reliability  │ │   Quality    │
│  Analysis &   │ │ Engineering │ │  Engineering  │ │   Control    │
│  Statistics   │ │             │ │               │ │              │
└───────────────┘ └─────────────┘ └──────┬────────┘ └──────────────┘
        ┌──────────────┬─────────────────┴┬──────────────┐
┌───────────────┐ ┌─────────────┐ ┌───────────────┐ ┌──────────────┐
│   Fracture    │ │   Testing   │ │  Design Eval  │ │    Parts     │
│    Control    │ │Failure Eval │ │   & Review    │ │  Evaluation  │
└───────────────┘ └─────────────┘ └───────────────┘ └──────────────┘
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Reliability Organization: SE Based

```
                    ┌─────────────────┐
                    │   Engineering   │
                    │     Manager     │
                    └─────────────────┘
         ┌───────────────────┼───────────────────┐
┌─────────────┐      ┌─────────────────┐      ┌─────────────┐
│   System    │      │     System      │      │  Research & │
│   Design    │      │   Engineering   │      │   Develop   │
└─────────────┘      └─────────────────┘      └─────────────┘
```

System Design	System Engineering	Research & Develop

Systems Analysis	Safety Engineering	Reliability Engineering	Human Factors

Maintainability Engineering	Logistics Engrg.	System Requirements

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Reliability Goals

- **Increase system effectiveness to:** _____
- **Increase system availability to:** _____
- **Increase MTBF to:** _____
- **Reduce warranty costs by:** _____
- **Reduce maintenance costs by:** _____
- **Increase system efficiency by:** _____
- **Increase system testing by:** _____

>15-1 se **9**

HORIZON MISSION (HMM/BTO)

SPACE PROGRAM

Current Appl.	PROVING TECHNOLOGY	ONGOING EXPLORATION

SYSTEMS ENGINEERING

Project A: Space Experiment

Phases

A	B	C	D	E

Logistics / Maintainability

Assurance: Reliability

Assurance: Safety & Quality

Manufacturing

Test and Evaluation

Research-- Engineering/ Sys. Analysis

Systems Engineering /
Program Management

PHASE A PRE. ANALY.	PHASE B DEFINE	PHASE C DESIGN	PHASE D DEVELOP/TEST	PHASE E -PROD, OPER., MAINT.

Others

Materials

Integrated Logistics Support/ Maintainability

Embedded Computer Resources

Assurance: Reliability

Assurance: Safety & Quality

Manufacturing

Test and Evaluation

Research-- Engineering/ Sys. Analysis

Phase A	Phase B	Phase C	Phase D	Phase E
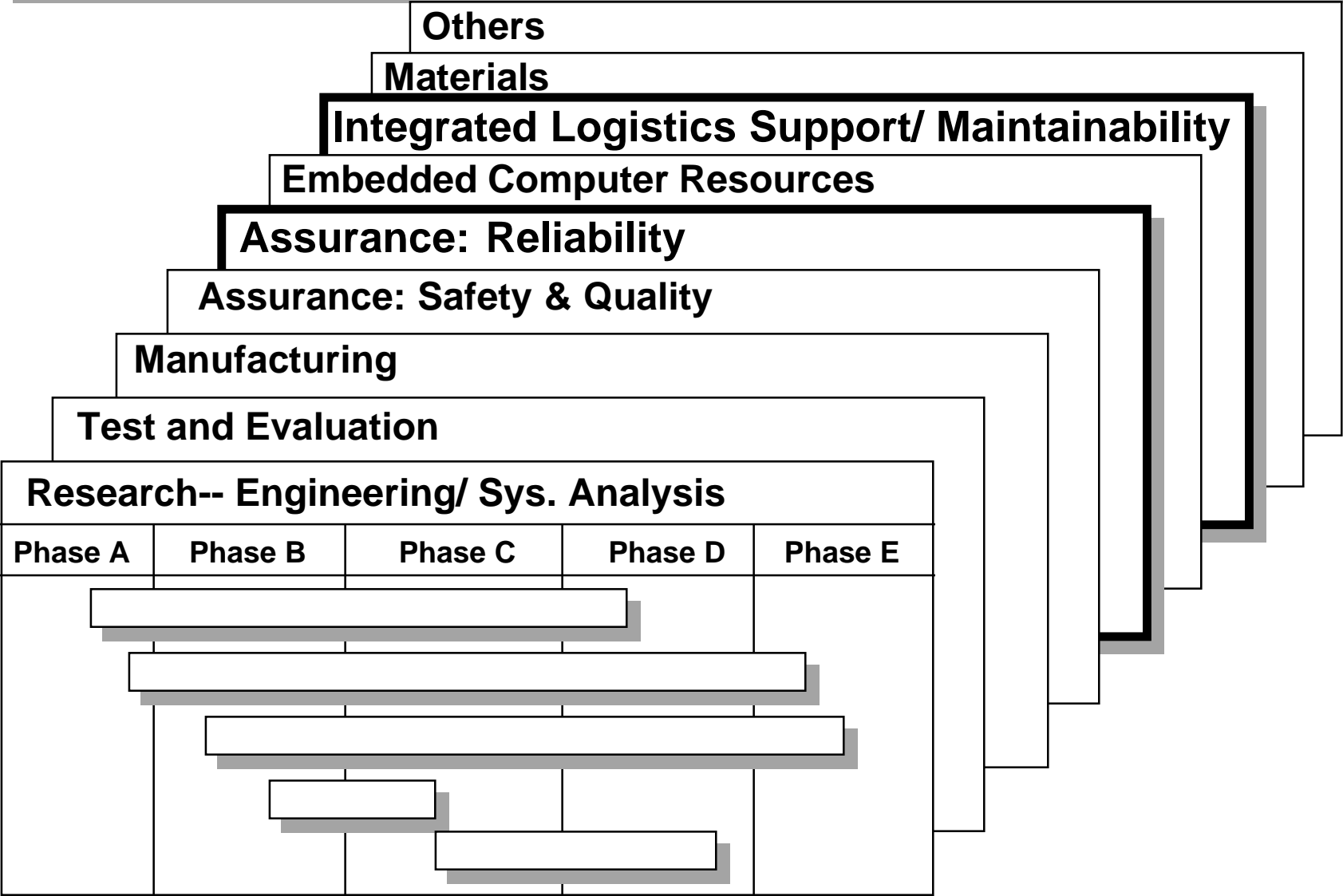
ASSURANCE: RELIABILITY ENGINEERING

PHASE A PRE. ANALY.	PHASE B DEFINE	PHASE C DESIGN	PHASE D DEVELOP/TEST	PHASE E -PROD, OPER., MAINT.
RELIABILITY MANAGEMENT				
		MONITOR/CONTROL SUBCONTRACTORS		
PROGRAM REVIEWS				
			PROBLEM REPORT & COR.ACT;LL	
			FAILURE REVIEW BOARDS	
	RELIABILITY MODELING			
	RELIABILITY ALLOCATION			
RELIABILITY PREDICTION				
	FAILURE MODE & EFFECTS ANALYSIS			
		CRITICAL ITEMS LIST		
		FAULT TREE ANALYSIS		

H

ASSURANCE: RELIABILITY ENGINEERING (con't)

PHASE A PRE. ANALY.	PHASE B DEFINE	PHASE C DESIGN	PHASE D DEVELOP/TEST	PHASE E -PROD, OPER., MAINT.
		SNEAK CIRCUIT ANALYSIS		
		ELECTRONIC TOLERANCE		
		MECH.PARTS ANALYSIS		
	PARTS PROGRAM (Using Failure Rate Data)			
		EFFECTS TEST, STORAGE, HANDLING etc.		
		TESTING: ENVIRONMENTAL STRESS SCREEN		
		RELB. GROWTH TESTS		
		RELB./QUAL.TEST PROGRAM		
			RELIABILITY GROWTH TESTING	
				PRAT PROGRAM
	SOFTWARE RELIABILITY & QUALITY ASSURANCE			

DESIGN FOR RELIABILITY

APPLICATION

BACKGROUND

RELB.BLOCK DIA.

DISTRIBUTIONS

MEASURING

RELB. PPDT

INTRODUCTION
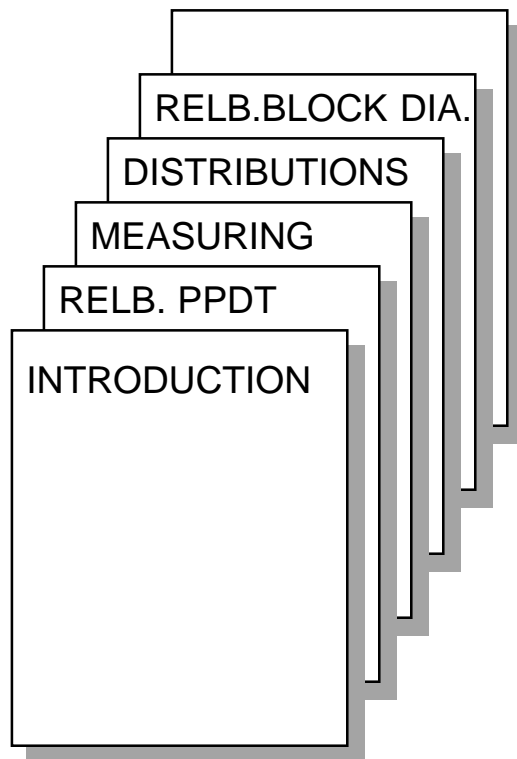
ASSURANCE: RELIABILITY ENGINEERING

PHASE A	PHASE B	PHASE C	PHASE D	PHASE E

RELIABILITY MANAGEMENT--
MONITOR/CONTROL SUBCTR.
PROGRAM REVIEWS---
PROBLEM REPORT &COR.,LL
FAILURE REVIEW BOARDS
RELIABILITY MODELING--------------------------
RELIABILITY ALLOCATION --------------------
RELIABILITY PREDICTION----------------------
FAILURE MODE & EFFECT ANALYSIS--------
CRITICAL ITEMS LIST---------------------
FAULT TREE ANALYSIS------------------
SNEAK CIRCUIT ANALYSIS-------------
ELECTRONIC TOLERANCE
MECH.PARTS ANALYSIS
PARTS PROGRAM, Using Failure Rate Data
EFFECTS TEST, STORAGE, HANDLING, etc.
TESTING: ENVIRONMENTAL STRESS SCRN.
RELB. GROWTH TESTS
RELB./QUAL. TEST PROGRAM
RELIABILITY GROWTH TESTING-----
PRAT
SOFTWARE RELIABILITY & QUALITY ASSURANCE

Establishing a Design for Reliability Program

- **Determine the reliability goals to be met.**
- **Construct a symbolic representation.**
- **Determine the logistics support and repair philosophy.**
- **Select the reliability analysis procedure.**
- **Select the data sources for failure rates and repair rates.**

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Establishing a Design for Reliability Program (cont.)

- **Determine the failure rates and repair rates.**

- **Perform the necessary calculations.**

- **Validate and verify the reliability results.**

- **Measure actual reliability.**

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Examples of Reliability Objectives for the Telecommunications Industry

- Goals should be placed in proper perspective.

- Large telecommunications networks:

    - At least one piece of equipment may be down at all times.

    - The user may not know this.

    - Operators consider that a system is down only when reported to them.

    - Short, self-clearing outages may go unreported.

- Reliability objectives can be defined differently for various systems.

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Examples of Reliability Objectives for the Telecommunications Industry

Module or System	Objective
Telephone instrument	Mean time between failures
Electronic key system	Complete loss of service
	Major loss of service
	Minor loss of service
PABX	Complete loss of service
	Major loss of service
	Minor loss of service
	Mishandled calls
Traffic Service Position Sys.(TSPS)	Mishandled calls
	System outage
Class 5 office	System outage
Class 4 office	Loss of service
Class 3 office	Service degradation

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Customer Specifications Targets

- **The satisfied customer sets the performance and availability requirements.**

- **Telecommunications networks should perform under stress:**
  - **Cable cuts.**
  - **Lengthy traffic overloads.**
  - **Equipment breakdown.**

- **Copper cable and fiber optic studies have shown:**
  - **56% of the cable pairs are cut.**
  - **100% of the fiber optic are cut.**

- **Cross-connects and allocatable capacity are used to dynamically reconfigure the network.**

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Reliability Growth From a Customer's Perspective

- **Growth Measurement must encompass the entire life cycle of the product.**

- **Corporations with a wide scope of product and/or product lines should not present overall reliability growth curves on an organizational basis. Individual product line reliability growth pictures should be presented to achieve total customer satisfaction.**

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Reliability Growth From a Customer's Perspective (cont.)

- **Because the customer's experience can vary with the maturity of a system, reliability growth is an important concept to the customer and should be considered in the customer's purchasing decision.**

- **The key is to define the goals for the product or service from the customer's perspective while reflecting on the actual situation in which the customer obtains the product or service.**

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Reliability Metrics

- **Reliability growth**

- **System uptime and availability**

- **Reduction in total life cycle cost.**

- **Failure reports processed.**

- **Number of lessons learned generated/published.**

- **Increased in calculated system reliability (increased MTBF) through recommendations.**

- **Number of failure modes identified and eliminated (based on potential for occurrence and seriousness of failure).**

- **Others: Your suggestions!!!**

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Reliability Growth: How much has the system improved.

CUM MTBF

TIME

23
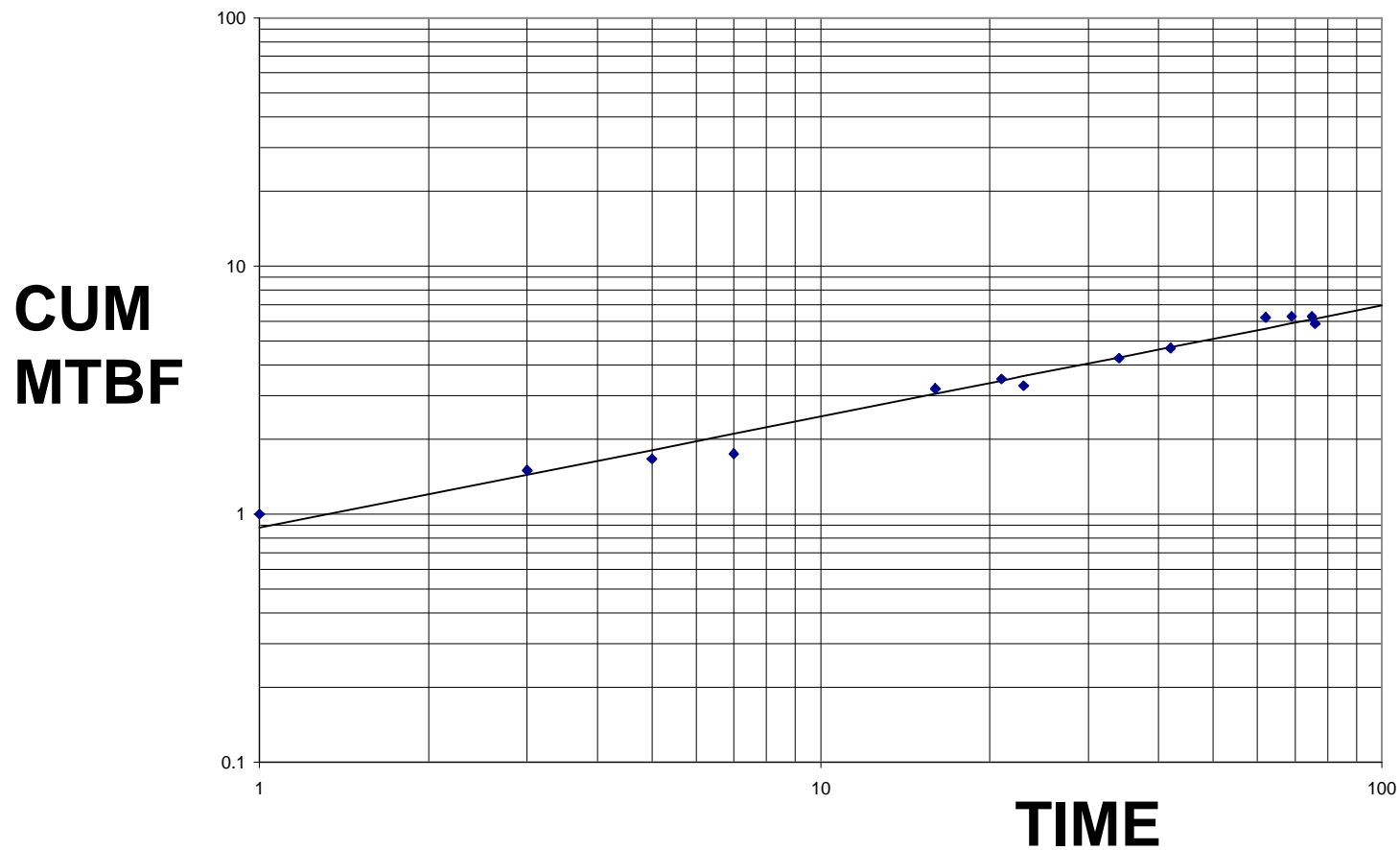
Reduction in Life Cycle Costs
(Based on Improved Reliability)

Cost

TOTAL COST OF OWNERSHIP

UNSCHEDULED MAINTENANCE

PURCHASE PRICE

SCHEDULED MAINTENANCE

Level of Reliability

24
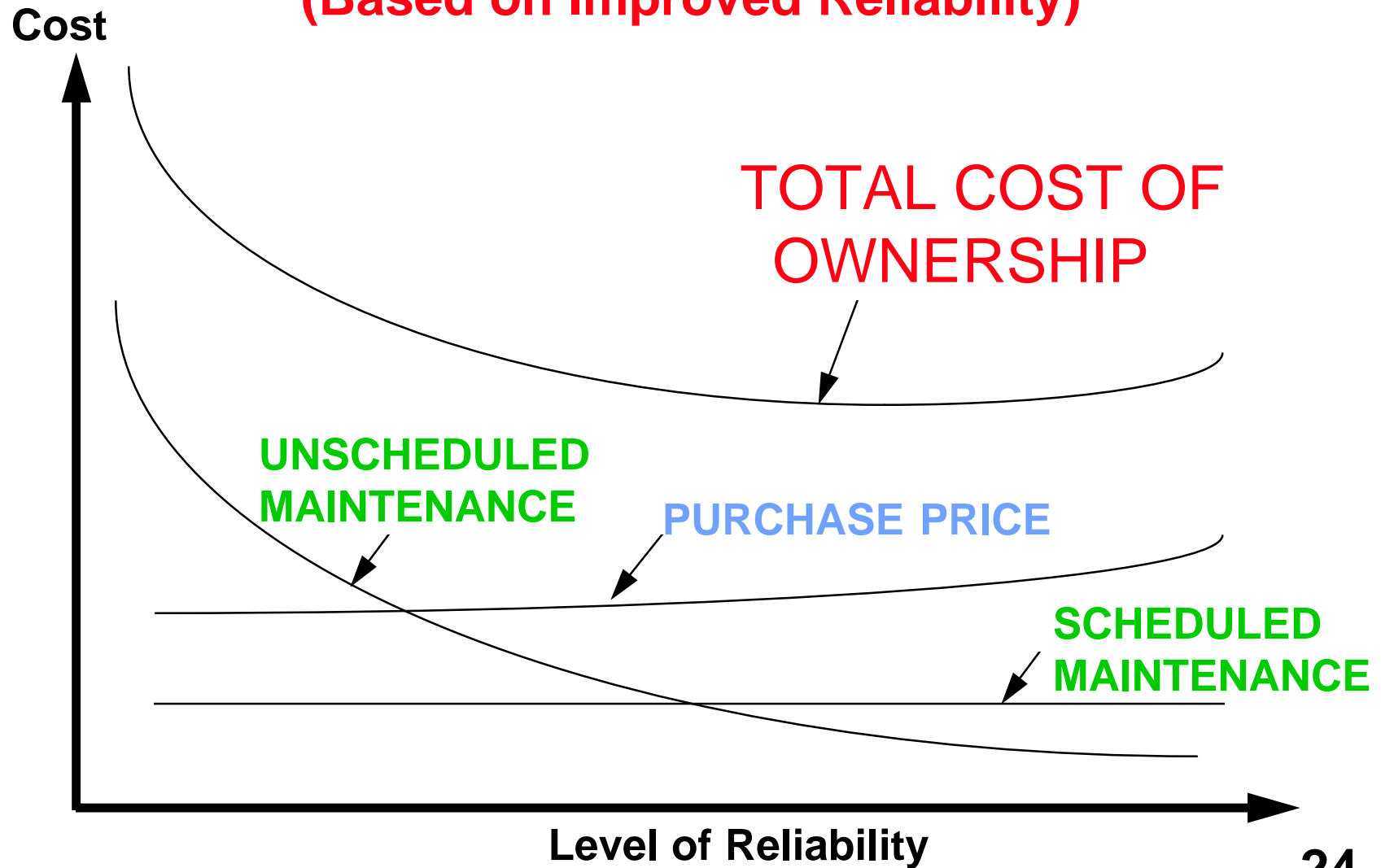
Failure Reports Closed and Lessons Learned Generated

Months

25
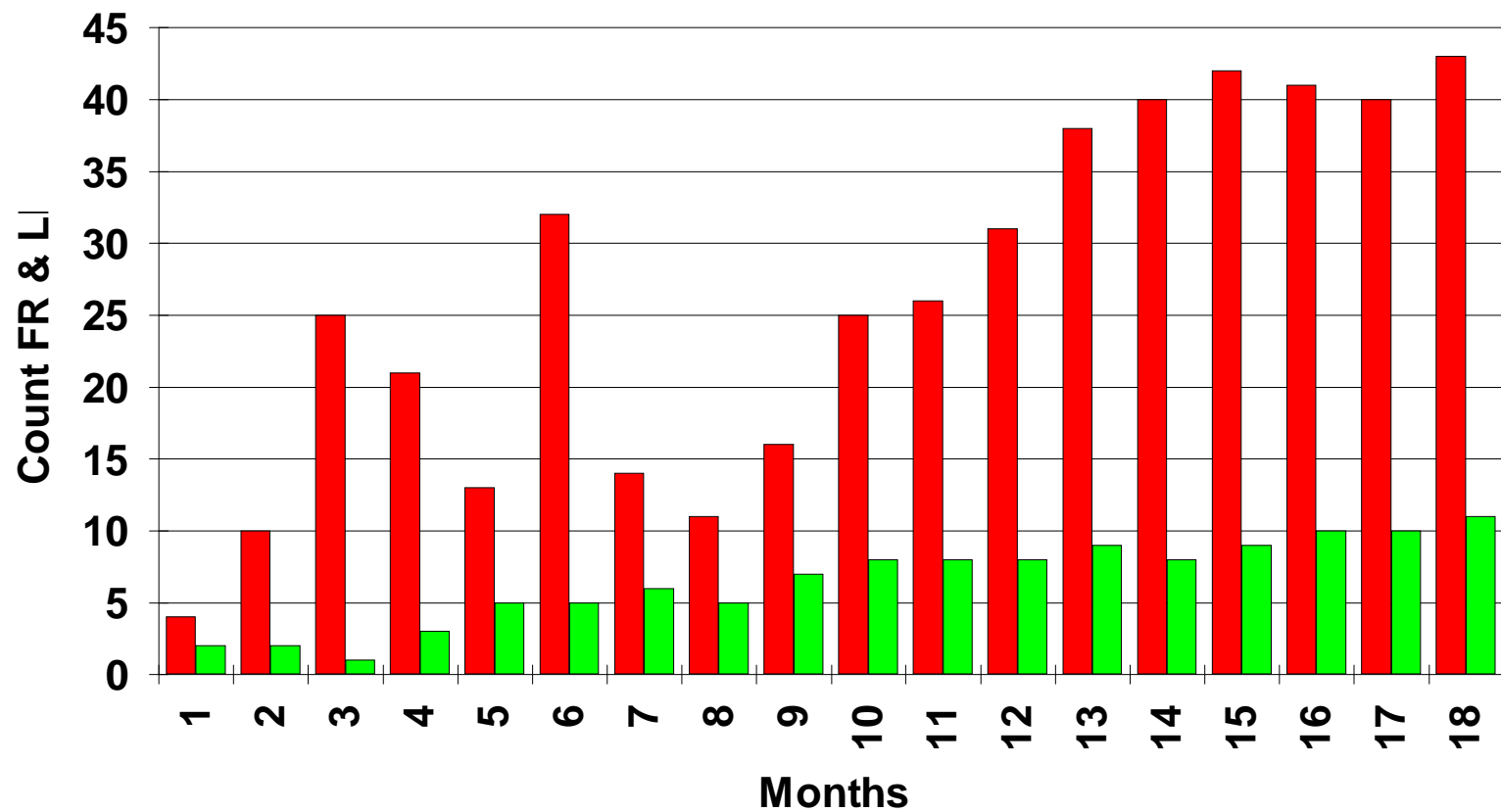
# Generation and Eliminations of Failure Modes, CRIT 1, 2, & 3
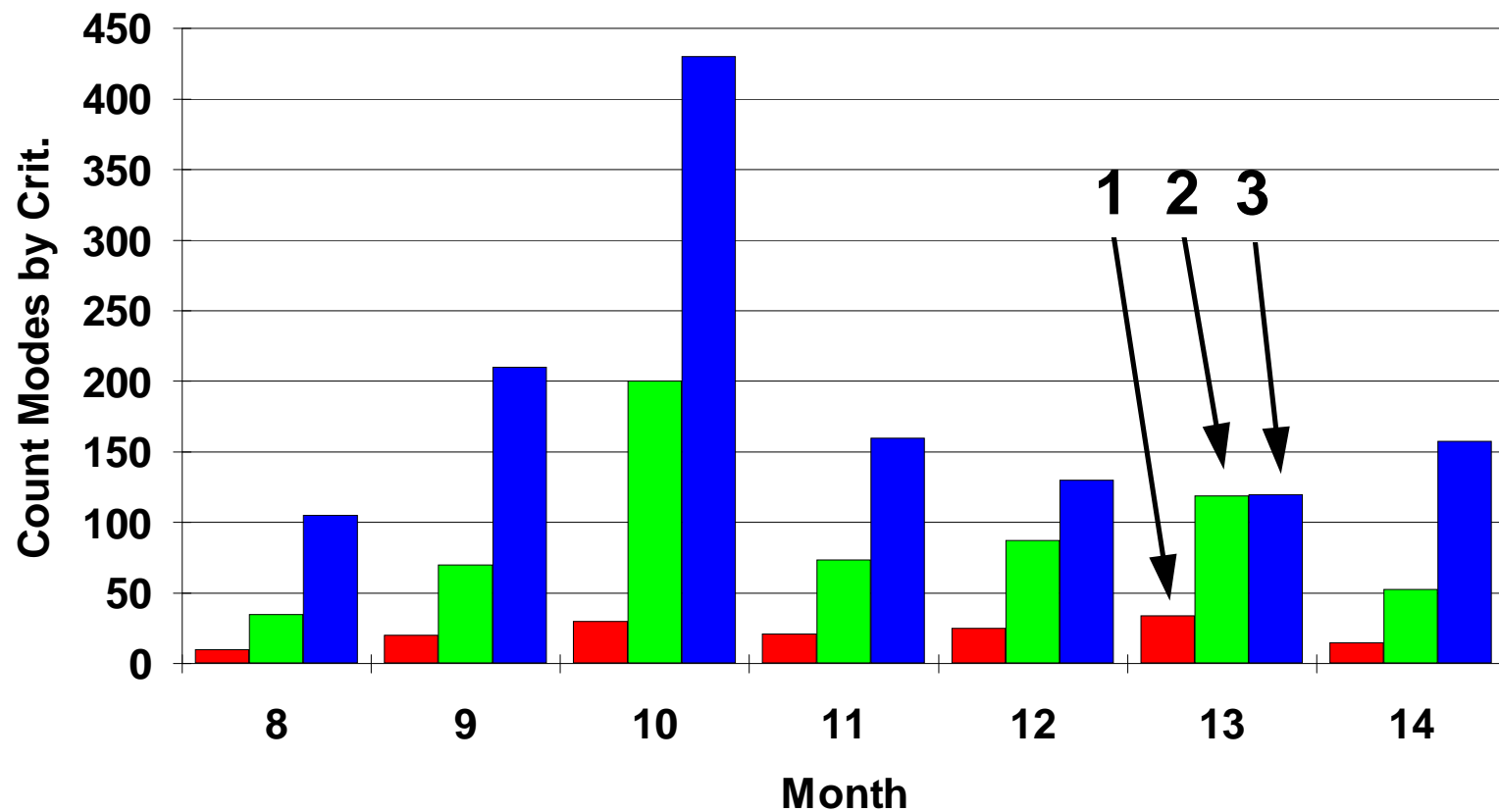
System Reliability
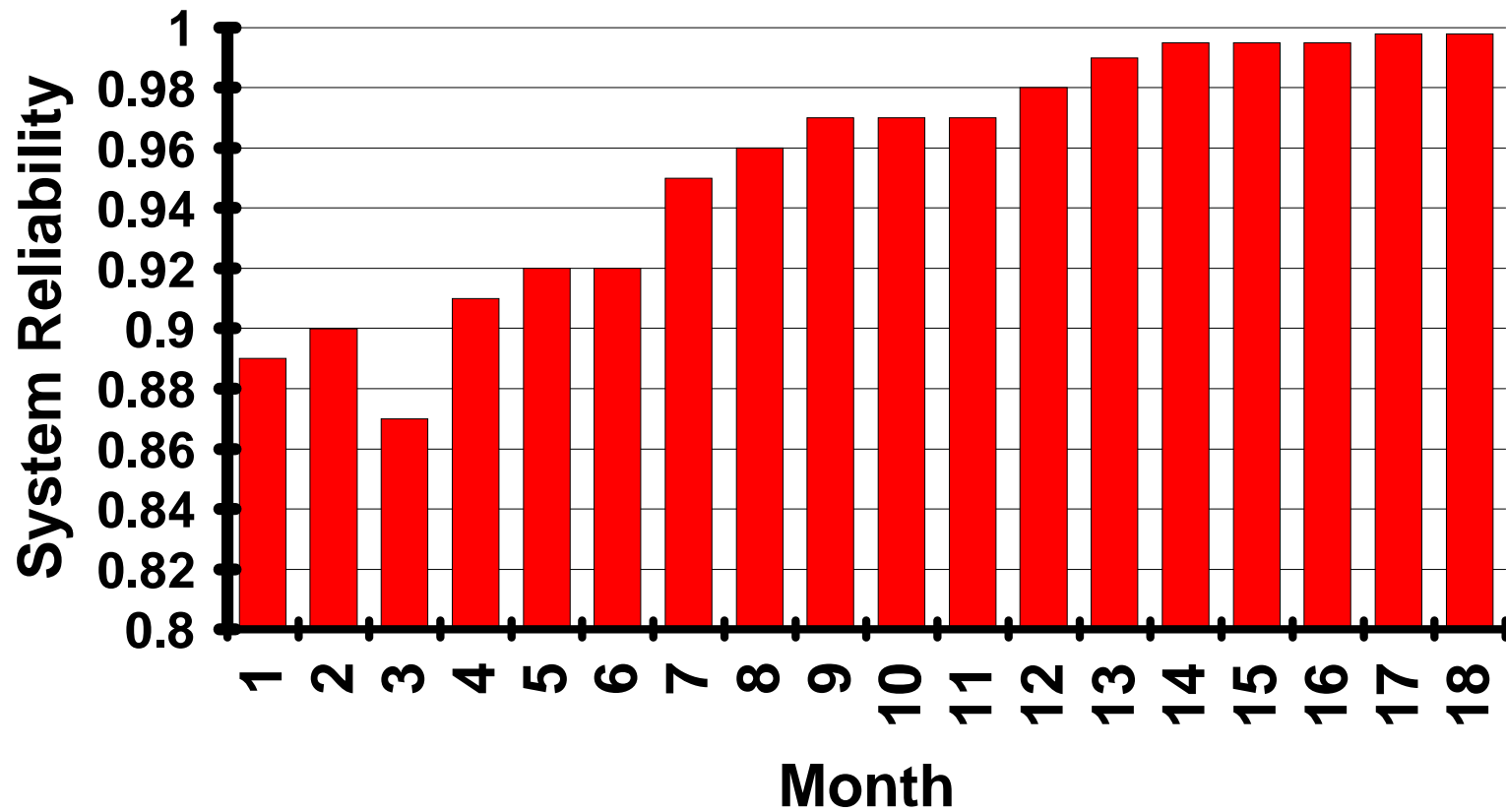
Human Reliability

- **Human reliability can be defined as "the probability of accomplishing a job or task successfully by humans at any required stage in system operations within a specified minimum time limit."**

- **It is the bridge between the user and the producer.**

- **Focus in design includes hardware, software, and human reliability.**

Human Reliability

OPERATOR RELIABILITY
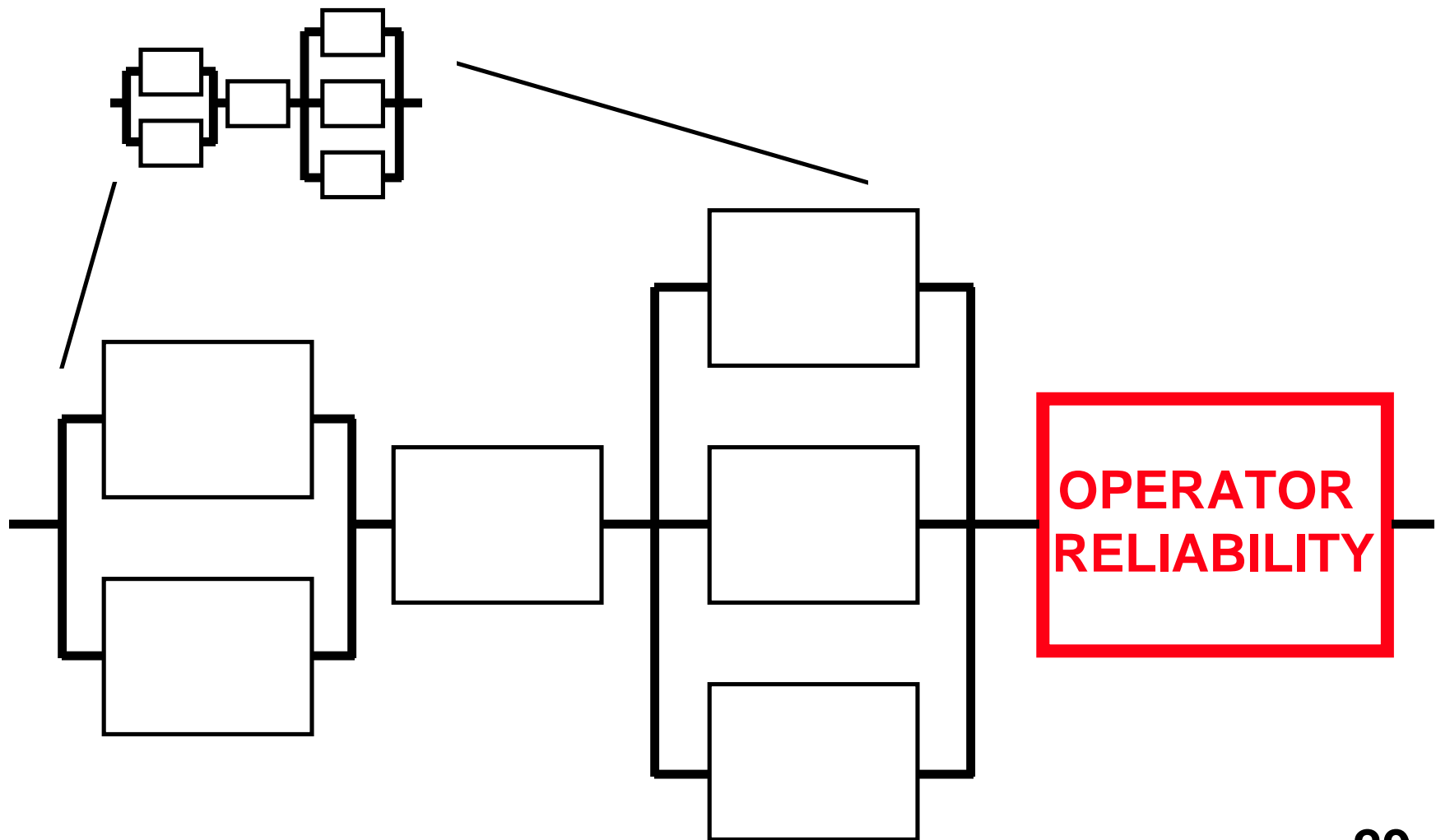
Human Reliability Design Goals:

- **Design for immunity to human error**
- **Design for easy human interface.**
- **Design to be user friendly.**
- **Prove out manuals and procedures.**
- **Minimize the likelihood of human error; especially errors that lead to unsafe conditions.**
- **Develop design checklists.**
- **Review for completeness and clarity.**

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Human Error: Wrong Connections In Electrical Hookup

- **Problem: wrong connectors mated after repair and units miswired.**

- **Solution: Different size connectors and common color wire throughout a cable run; also unsymmetrical connectors.**
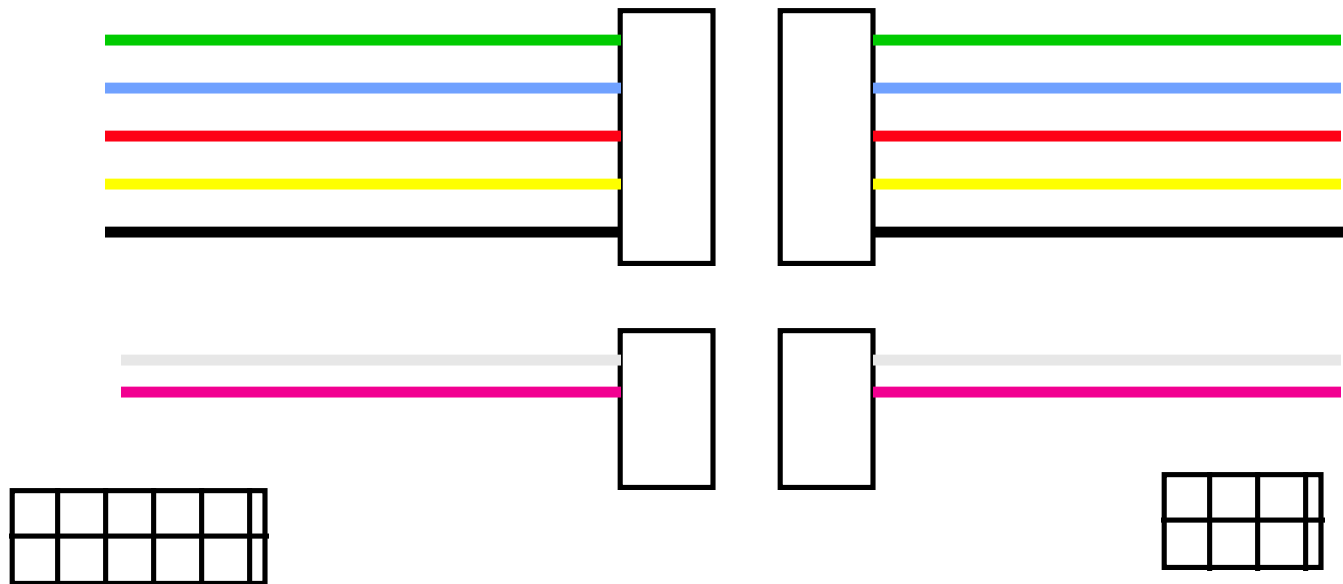
Human Error: Scalding from Water Faucets/Showers.

- **Problem: Confusing knobs, colors and on/off rotational directions.**

- **Solution: standardization: Hot on left, Hot colored red, cold colored blue; clockwise to close (right hand screw); thermal temperature limiter in water delivery system. Different size labels and attachment points.**
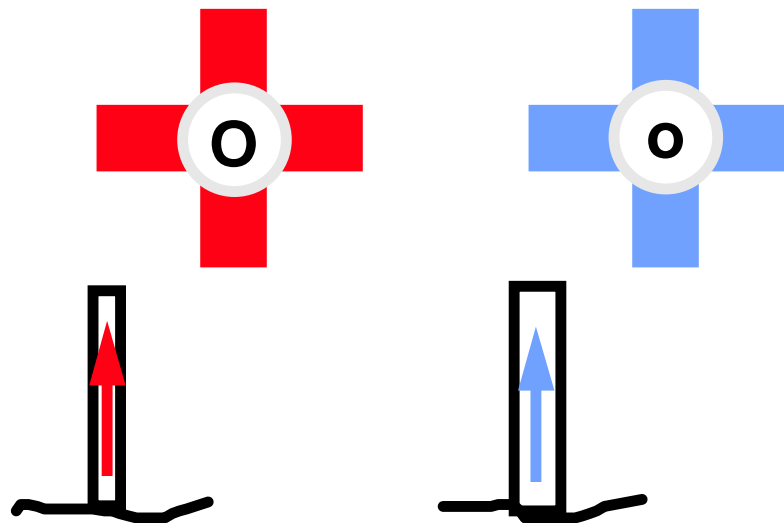
Easy Human Interface

- **Switches located on graphical model of system.**
- **Switches mounted in order of use, left to right.**
- **Graphical presentations on screens as well as text.**
- **Single point disconnects for emergency systems.**
- **Standard colors for conditions: red/yellow/green.**
- **Vocal warnings of improper conditions.**
- **Test system and layout for stereotype behavior.**
- **Standardize layouts.**
- **Most frequently used controls in favorable positions.**

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User Friendly

- **Elegance of design.**
- **Hierarchy of options. Allow easy to use series of operations and extended operations separated from those.**
- **Prove out design with untrained personnel.**
- **Don't skimp on human interface (e.g. quality of materials, colors, seating, knobs, keyboards, screen quality, etc.**
- **Provide real time training.**
- **Allow defaults to have nominal operation of system.**

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Types of Human Errors

- **Errors of vision**
- **Errors of insufficient knowledge.**
- **Equipment not calibrated properly.**
- **Difficult to inspect.**
- **Design for emergency situations.**
- **Design for typical behavior.**

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Prove Out Manuals and Procedures

- **Use FMEA and Fault Trees to generate block diagrams of diagnostics.**

- **Write manuals to help operators and maintenance personnel. Do not write manuals to write manuals.**

- **Take uninvolved personnel, give them a manual, LEAVE, and allow them to try to use it. THEN MAKE REVISIONS and give it to new uninvolved personnel.**

- **Give clear warnings, cautions and suggestions.**

- **Write with levels of detail.**

- **Be concise and precise.**

- **Revise the manual when the system is revised.**

- **Use checklists unless the operators can name all 50 states from memory.**

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Reliability Management - Conclusions

- Determine the reliability goals to be met.

- Spell the program requirements out in detail as well as how the results will be implemented.

- Do reliability analyses in draft form that never have to be published (e.g. alert engineers to dangerous conditions and help them eliminate them before they get into the system).

- Validate and verify the reliability results.

- Measure actual reliability.

- Human reliability is a key factor to consider to have a successful, reliable and safe product.

- Reliability analysis should continue throughout the product life-cycle.

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